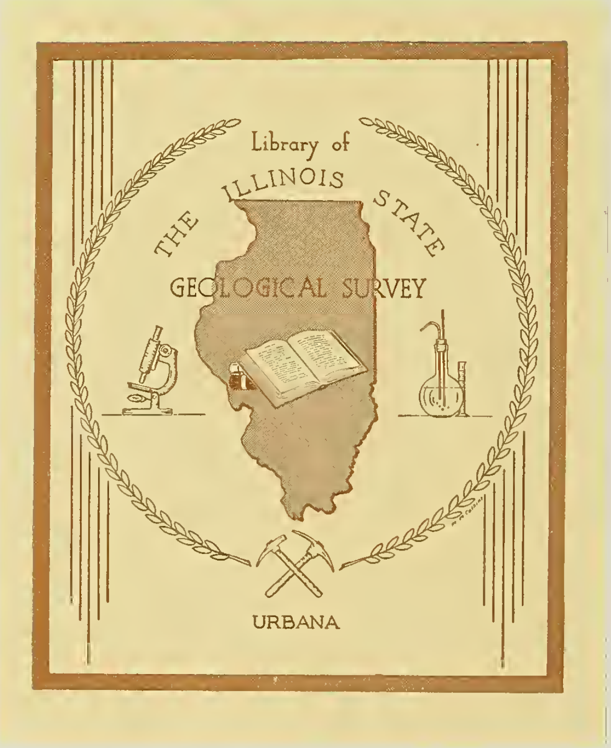

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GEOLOGY AND ENGINEERING CHARACTERISTICS OF SOME SURFACE MATERIALS IN MC HENRY COUNTY, ILLINOIS

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ILLINOIS STATE GEOLOGICAL SURVEY
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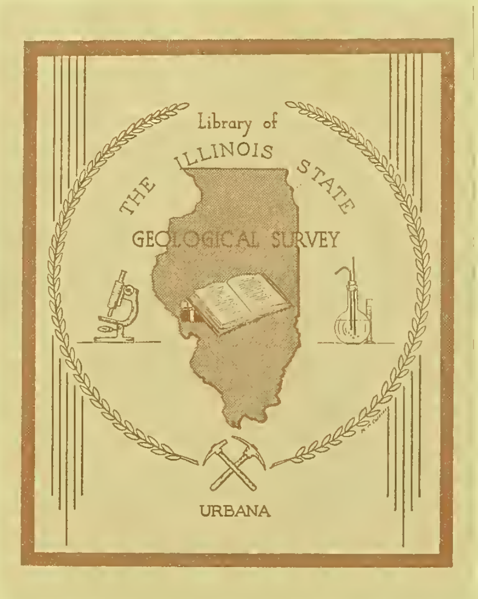

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GEOLOGY AND ENGINEERING CHARACTERISTICS OF SOME SURFACE MATERIALS IN McHENRY COUNTY, ILLINOIS

W. Calhoun Smith

INTRODUCTION

Conservation and proper utilization of all natural resources are important facets of the long-range plan being developed by the McHenry County Planning Commission. To assist the commission, the Illinois State Geological Survey has set up a data-collecting program, of which this report is a part. The report considers the physical and mineralogical composition and certain engineering properties of the surface materials in the county and estimates their behavioral characteristics.

From visual observation of surface materials in the county, one is impressed with the widespread occurrence of permeable sand and gravel deposits, which readily absorb normal rainfall. The broad valleys are underlain by sand and gravel, and the upper few feet of material covering these valleys consists of sand, silt, clay, muck, and peat in apparently heterogeneous arrangement. The water table is high in many of the valleys, and swampy, boggy areas are common. Peat deposits as much as 40 feet deep have been reported. Ponds are readily created at many places in the valleys simply by excavating below the shallow water table and allowing ground water to fill the excavation.

Heavy structures could probably be founded successfully on the sands and gravels in the broad valley areas, although water problems might be encountered during construction. However, the materials overlying the sands and gravels probably would be subject to differential settlement and for this reason would provide hazardous foundations at best. Any major construction or other engineering installation in the valley areas or on the uplands should be preceded by exploration to determine the nature and

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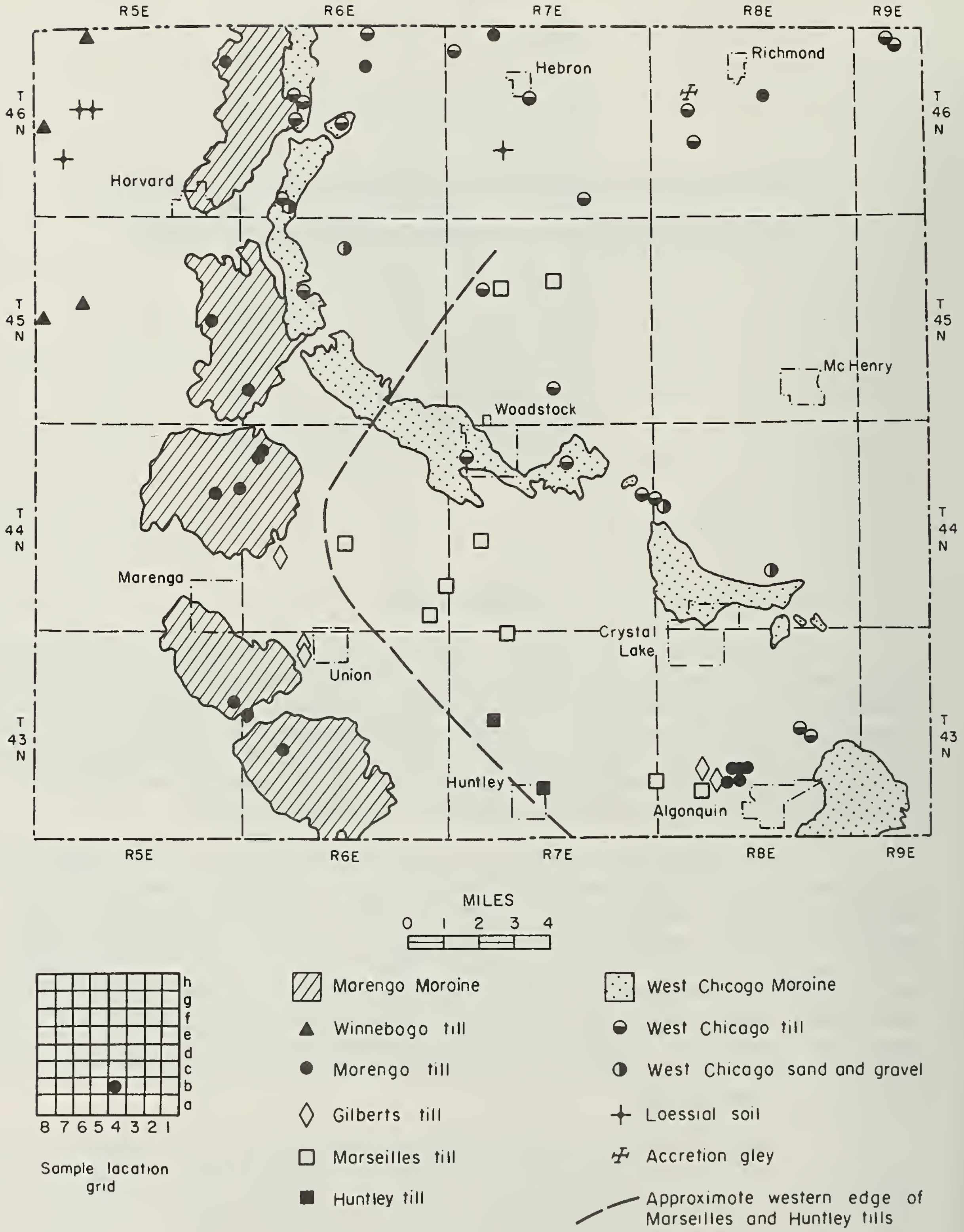

Fig. 1 - Sample locations, McHenry County, Illinois.

severity of possible foundation problems as well as the exact nature of the ground at the site.

MATERIALS SAMPLED

Illinois Geological Survey Circular 336, "Sand and Gravel Resources of McHenry County, Illinois," by Richard C. Anderson and Douglas A. Block, describes the extensive sand and gravel deposits and includes a map outlining their locations. This map was used as a guide in choosing sampling locations for the present study. Samples were obtained from upland areas, largely end moraines, and from other areas where deposits other than sand and gravel are exposed.

Seventy-two samples of fresh and weathered material were collected and analyzed. The results of the analyses are given in tables 1 and 2 at the end of the report. Six glacial till units were identified and sampled from the outcrop and by augering. In addition, four samples of sand and gravel and four of loessial soil were collected. Three samples of a fine-grained, pebble-free, lacustrine deposit, similar to a deposit in eastern McHenry County, were collected from western Lake County.

Two topographically prominent end moraines, the Marengo and the West Chicago, cross McHenry County, as shown in figure 1. Samples of till were taken from each moraine and from locations behind them. Several other tills were sampled from other locations in the county (fig. 1).

SAMPLE IDENTIFICATION

The samples were numbered and given a location designation. In the tables the locations are referred to the 15-minute quadrangle and to township, range, section, and approximate position within the section. For instance, sample 17 was collected in the Harvard Quadrangle; its location is further indicated by 46N5E-5.4b, which means township 46 north, range 5 east, section 5, and position 4b within the section. As shown on the sample location grid in figure 1, a normal section is divided into 64 squares of 10 acres each, each square representing a quarter of a quarter of a quarter of a section. The rows of squares are numbered from east to west and lettered from south to north. Location 4b is 4 squares west and 2 squares north of the southeast corner of section 5.

DISTRIBUTION OF IDENTIFIABLE GEOLOGIC UNITS

In the upland areas of McHenry County, six till units have been identified. In the western part of the county, the surface drift is the Winnebago till, but this unit is covered by the products of its own weathering and/or by several feet of loessial soil. The Marengo Moraine is a ridge that crosses the county in a north-south direction at about the longi-

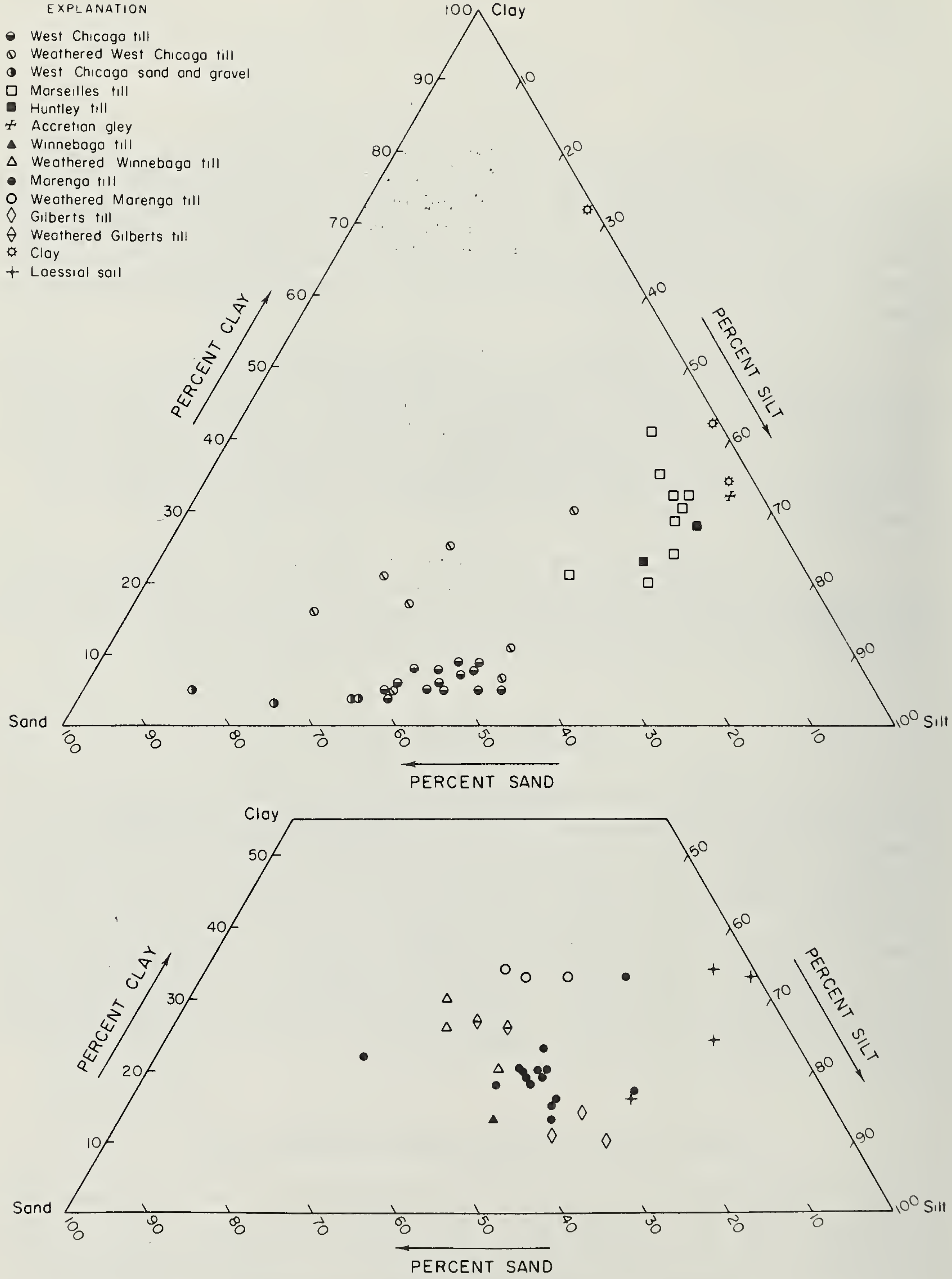

Fig. 2 - Grain-size triangles showing physical composition of the nongravel fraction of the samples studied.

tude of the cities of Harvard and Marengo. The Marengo till that composes this ridge is a distinctive pink to red, silty, sandy till that is easily recognized because of its color. The till is as much as 200 feet thick at some places, and borings reveal the presence of an organic zone between the red Marengo till and the underlying Winnebago till (John P. Kempton, personal communication, 1967). The organic zone is peaty at some places. The Gilberts till is closely associated with the Marengo, having a similar composition and a slightly reddish color. Taken together, these two units constitute the "red drift" of McHenry County.

The red drift apparently underlies all of the county east of the Marengo Moraine. Samples were collected at exposures north of Hebron, southeast of Richmond, and near Algonquin. It is believed that an irregular or hilly topography existed on the red drift and west of it prior to deposition of the overlying units.

The Huntley and Marseilles tills overlying the red drift are very similar to each other and are closely associated. Samples of Marseilles and Huntley tills were collected from scattered exposures in an arcuate band 4 to 5 miles wide passing through the cities of Huntley and Woodstock. The western edge of this band is indicated by the dashed line in figure 1. This line may also mark the approximate western edge of the Marseilles and Huntley tills in McHenry County. Though exposures are not abundant, Marseilles and Huntley tills may be present beneath the younger drift at many places in the eastern part of the county. Prior to deposition of West Chicago materials, the topography of McHenry County was probably hilly, with deposits of the red drift and of the Marseilles and Huntley tills composing the topographic prominences in the eastern three-fourths of the county and Winnebago till the hills along the west side.

The West Chicago Moraine crosses McHenry County in an irregular arc (fig. 1). About 3 miles east of Harvard, the moraine forms a high north-south ridge that rises to an elevation of nearly 1200 feet. The moraine trends southeastward through Woodstock and passes out of the county near the southeast corner. Recent work by David L. Gross (personal communication, 1967) indicates that the moraine between Woodstock and Algonquin is highly variable and in some places consists largely of sand and gravel.

The West Chicago drift in McHenry County is principally sand and gravel, much of it water laid. The undisturbed West Chicago till is very sandy and gravelly, generally with less than 10 percent clay. It is only about 4 or 5 feet thick in the eastern part of the county and possibly as much as 30 feet thick along the moraine. West Chicago materials are widespread in McHenry County and appear to have drowned the hilly topography that existed prior to their influx.

RESULTS OF LABORATORY ANALYSIS

Grain-size analyses are given in table 1 and are shown plotted in figure 2. Percentage by weight is given for each size fraction, but only the percentage of gravel is based upon the whole sample. The percentages

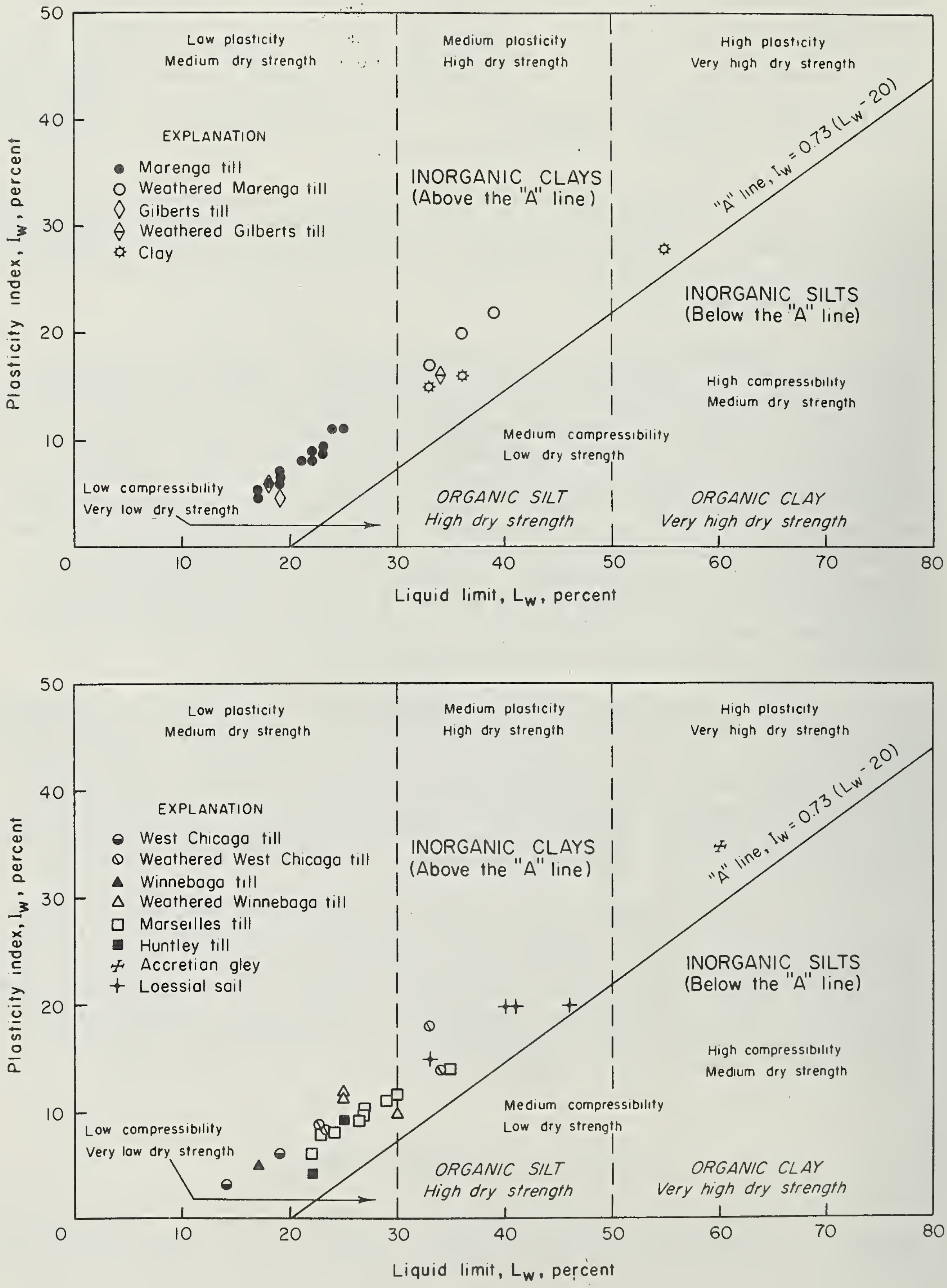

Fig. 3 - Casagrande plasticity chart showing plasticity and potential dry strength characteristics of the materials studied.

of sand, silt, and clay were calculated for the sample after the weight of material larger than 2 mm was subtracted from the total weight of sample analyzed.

Atterberg Limits

The natural water content and the Atterberg limits (liquid limit, plastic limit, and plasticity index) also are given in table 1. The Atterberg limits provide numerical values that are widely used by engineers to characterize the consistency of plastic soils. The liquid limit is the water content of the soil at the boundary between the liquid and plastic states. The plastic limit is the water content of the soil at the boundary between the plastic and semisolid states. The water contents are expressed as a percentage of the dry weight of soil solids. The plasticity index is the difference between the liquid and plastic limits and represents the range of water contents through which a soil is plastic. The Atterberg limits were determined on the fraction of each sample that passed through an 8-mesh sieve having openings of 2.362 mm. While this size is coarser than is commonly recommended, the results are thought to relate more directly to the characteristics of the material in place. In figure 3, the liquid limit and plasticity index of the samples for which Atterberg limits were obtained have been plotted on the Casagrande plasticity chart to show the plasticity and potential dry strength of the materials.

Mineralogical Composition

The mineralogical composition was obtained by X-ray diffraction, and the results of this work are given in table 2. The nonclay mineral composition is given as intensity values obtained by subjecting the powdered whole sample to X-ray. The clay mineral composition is expressed in parts in ten calculated from X-ray diffraction patterns obtained from oriented aggregates of the clay fraction on glass slides.

Activity Index

Activity and liquidity indices are values calculated from the laboratory test data that give some additional engineering information about a soil. Activity and liquidity index values are given in table 3.

The concept of activity was developed in an effort to assess quantitatively the contribution of the clay minerals in a clay material to such engineering properties as cohesion and plasticity. Activity is calculated by dividing the plasticity index by the percentage of clay-size material in the sample. Three classes of clay materials are generally recognized—inactive, normal, and active—and these have been further subdivided into the following five groups:

Group 1	Inactive	Activity less than 0.5
Group 2	Inactive	Activity 0.5 to 0.75
Group 3	Normal	Activity 0.75 to 1.25
Group 4	Active	Activity 1.25 to 2.0
Group 5	Active	Activity more than 2.0

Of the samples for which activity values could be calculated, only five fall in the normal group; all others are in the inactive category, with 30 of the 43 falling in group 1, which shows activity values of less than 0.5. Such a low activity value indicates that the clay minerals make but a small contribution to the engineering properties of the soil materials in their natural state.

Liquidity Index

The consistency, or stiffness, of a cohesive soil is directly dependent upon its water content, but the natural water content alone gives almost no information about the consistency. However, the difference between the natural water content and the plastic limit can be divided by the plasticity index to give a number called the liquidity index, which provides a measure of the consistency of the soil. When the liquidity index equals one, the consistency of the soil is that at the liquid limit, or very soft. When the liquidity index equals zero, the consistency of the soil is that at the plastic limit, or stiff to very stiff. Hence, positive values of the liquidity index indicate that a soil contains more water and is softer and more plastic than the same soil at its plastic limit. Negative values, on the other hand, indicate that a soil is drier and stiffer than the same soil at its plastic limit. Negative liquidity index values and positive ones near zero indicate that a soil has been preconsolidated by some means.

Table 3 reveals that the liquidity index value is negative for 29 of the 40 samples for which it could be calculated and that the positive values are low. Of the eight samples having positive values, only one had a value above 0.40, three had values lower than 0.25, and four had values between 0.25 and 0.40. Three samples had liquidity index values of zero. The low and negative liquidity index values indicate that the materials in their natural state have a stiff rather than soft consistency. This, in turn, indicates satisfactory bearing strengths for ordinary construction.

The consistency of a soil can be changed by changing its water content. The above remarks concerning liquidity index relate only to the materials in their natural state, or, really, to the material as sampled. If the soil environment is changed from relatively dry to very wet, a given soil can be expected to absorb water and develop a softer consistency and more plasticity along with a corresponding increase in liquidity index value and a probable decrease in supporting capacity.

A cohesive soil, that is, one having considerable clay mineral content, is not only a physical system but a chemical system as well. The introduction of chemicals to a clayey soil may cause loss of strength or increased swelling and shrinkage. Work with separate clay minerals has shown that the effects of chemicals differ for different clay minerals. The behavior of a cohesive soil as a chemical system depends upon a wide array of factors and has been discussed by W. Arthur White in Illinois Geological Survey Environmental Geology Note 12. White pointed out that the chemicals in septic tank effluents and industrial wastes may cause undesirable changes, such as loss of stability, in the physical properties of clay materials.

ENGINEERING CHARACTERISTICS OF IDENTIFIABLE GEOLOGIC UNITS

Some of the statements in the following paragraphs are formulated directly from information in the tables and figures of this report without specific reference in each instance. Other statements, particularly those regarding behavior characteristics, are judgments and estimates based upon information in the tables and figures plus observation of the geologic units in place.

Winnebago Till

Eighty-seven percent of sample 41, the only sample of relatively unaltered Winnebago till, consists of sand and silt with enough clay to bind the material together. Illite is the predominant clay mineral. The plasticity and activity indices are low, probably reflecting the low clay content. On the plasticity chart, this sample lies in the area of low plasticity and medium dry strength. Its negative liquidity index indicates a stiff to very stiff material. It would provide good bearing strength and would be slowly absorptive of water.

Samples 17 and 20 are considered to be weathered Winnebago till and are somewhat more clayey than the fresh material; they also have higher natural water contents and higher plasticity indices. These samples contain more montmorillonite and mixed-layer clay minerals than the fresh material, which may represent some admixture of loess as well as the products of weathering. Sample 21 is included with the weathered Winnebago till, but it has a different composition and may represent a weathered deposit of sand and gravel. The weathered material would be removed for any major construction.

Marengo Till

This till is widespread in McHenry County and is readily recognized by its pink to red color. It is primarily a sandy, clayey silt with some pebbles. The samples studied are relatively uniform in grain size except for sample 65, which was taken near the radio tower north of Marengo. This sample contains more clay than the others and may represent a facies change within the Marengo. Liquid limits range from about 17 to 25 and plasticity indices range from 5 to 11. On the plasticity chart, the fresh Marengo samples fall in the region of low plasticity and medium dry strength, whereas the weathered samples have medium plasticity. The predominant clay minerals in the Marengo till are illite, chlorite, a small amount of kaolinite, and a little montmorillonite plus mixed-layer clay minerals. Well defined montmorillonite is absent except in two samples of weathered Marengo, and even this may represent an increment derived from loess.

Owing to its significant sand content and generally large amount of silt, the Marengo should be moderately absorptive of water but relatively slow in draining. Most of the liquidity index values are negative, indicating a stiff to very stiff material in place. It has adequate bearing strength in its natural state, but if subjected to a continuously very wet environment it would tend to become water-logged and lose some stability.

Once saturated, the Marengo till probably would lose its water and regain stability very slowly, for it has been observed in the laboratory that this material dries slowly. While this probably would not be an extremely serious problem, it should be taken into account in planning major construction projects that would be founded on Marengo till. Activity values are moderate, indicating that the clay fraction would make some contribution to the properties of the material.

Gilberts Till

The Gilberts till is somewhat less clayey and more silty than most samples of Marengo till, but its grain-size distribution is very close to that of the Marengo, as is shown by the plotting of these two tills in the same general area on the triangular diagrams. Liquid limits and plasticity indices appear to be slightly lower than for the Marengo till, but not significantly so. As in the Marengo till, the principal clay minerals in the Gilberts till are illite and chlorite, and the two tills are closely associated both spatially and compositionally.

In its natural state, the Gilberts till would probably have engineering properties very similar to those of the Marengo till. It should be moderately absorptive of water but not free draining and would probably lose some stability if it became saturated with water. In its dry condition it would have sufficient bearing strength for ordinary construction projects. On the plasticity chart the Gilberts till samples fall in the area of low plasticity and medium dry strength, as do the samples of Marengo till.

Marseilles Till

The Marseilles till is known from a number of exposures in the central and southern part of McHenry County (fig. 1). It is typically gray, very compact, very clayey silt with some sand and a little gravel. Its liquid limit ranges from 22 to about 35 percent, and its plasticity index ranges from about 6 to 14 percent. The predominant clay minerals are illite and chlorite. Activity values are low, indicating that although the clay fraction will contribute to the behavioral characteristics of the till the contribution is moderate. On the plasticity chart, only one sample of Marseilles till falls in the area of medium plasticity and high dry strength; all others are in the region of low plasticity and medium dry strength. The liquidity indices are all negative, indicating a stiff to very stiff consistency.

The Marseilles till is slowly to very slowly absorptive of water, and where it underlies thin deposits of permeable materials it could cause drainage problems, for instance when used as a septic tank field. In its dry condition it will have adequate bearing strength for most construction projects, but it might develop some plasticity if allowed to become saturated. The Marseilles till would be a satisfactory material for the construction of embankments for the impoundment of water.

Huntley Till

The Huntley till is very similar to the Marseilles till, both texturally and compositionally (tables 1 and 2; fig. 2). On the plasticity chart the Huntley till, as does the Marseilles till, falls in the region of low plasticity and medium dry strength. Activity values are low and the liquidity index values are negative. Engineering properties of the Huntley till are very similar to those of the Marseilles till.

Clay (Lake County)

Three samples of a pebble-free, calcareous clay were collected from the western part of Lake County. This clay is apparently lacustrine in origin and is tentatively considered to be the Lake Wauconda clay belonging to the Minooka glaciation. Similar clay has been reported (David L. Gross, personal communication, 1967) in the eastern part of McHenry County.

Sample 50 was taken from an outcrop in the town of Channel Lake and sample 53A was dredged from the bottom of Grass Lake. These samples are both very clayey silt, and on the plasticity chart they lie in the area of medium plasticity and high dry strength. Both samples have low activity; sample 50 has a liquidity index of zero, indicating a very stiff consistency in the natural state. The predominant clay minerals in the clay from Channel Lake are illite and chlorite. The clay is compact and can be considered almost impermeable from a practical standpoint. Where it underlies thin deposits of pervious materials, it would probably cause drainage problems, for example, if used as a septic tank field. It would have adequate bearing strength for most construction projects if protected from saturation. It would probably be a satisfactory impervious material for the construction of embankments for the impoundment of water.

Sample 53B is a silty clay dredged from the bottom of Grass Lake; it was collected from an embankment being constructed to enlarge a marina. It contains 72 percent clay, and on the plasticity chart it falls in the area of high plasticity and very high dry strength. The predominant clay minerals are illite and chlorite. Its activity is low, and its liquidity index is zero. This sample is of little importance except to record the presence of such material in the bottom sediments of Grass Lake.

West Chicago Drift

The West Chicago drift, both till and sand and gravel units, is principally silty sand and gravel with a small amount of clay. As shown on table 1, Atterberg limits could be obtained for only two of the fresh samples and four of the weathered ones because the materials are simply too sandy. Therefore, the West Chicago materials are classed as granular materials having little or no plasticity. The weathered West Chicago till samples contain more clay than the fresh samples. This may represent, in part, an increment derived from loess. The predominant clay minerals are illite and chlorite with small amounts of kaolinite and of montmorillonite plus mixed-layer clay minerals. Activity values have a wide range, with two samples falling in the normal category. Of the five liquidity index values that could be calculated, three are negative.

Being largely sand and gravel, the West Chicago materials are free draining. They have adequate bearing strength for most construction projects. In some areas they may contain sufficient water to be troublesome during construction. Drainage problems might also be encountered in areas where thin West Chicago materials are underlain by relatively impervious units such as the Marseilles or Huntley tills.

Accretion Gley

The one sample of accretion gley analyzed is a very clayey silt, the clay being almost all illite and montmorillonite plus mixed-layer clay minerals. This material would have little bearing strength when wet and would be subject to considerable swelling and shrinkage upon alternate wetting and drying. It would be very slowly permeable except along joints and fissures. The accretion gley on the plasticity chart falls in the area of high plasticity and very high dry strength. Its plasticity index of 35 and its activity of 1.09 are the highest values obtained in this study. Accretion gley deposits are probably widespread in the broad valley areas and may also be present at some places on the uplands. They would not make satisfactory foundation materials and should be removed before construction begins.

Loessial Soil

The surface of all of McHenry County has probably received some wind-blown silt or loess, but the deposits are thin over much of the county. Four samples are considered to be of loessial origin, principally because of their high silt content. Samples 5 and 6 can be called loessial soils with confidence because of their nearly complete lack of gravel and because of the large amount of montmorillonite they contain. Samples 18 and 19 may be a mixture of loess and weathered Winnebago drift. They contain a little gravel and are high in montmorillonite plus mixed-layer clay minerals. Texturally, samples 5 and 6 are similar, but samples 18 and 19 do not group with samples 5 and 6 on the triangular diagram (fig. 2). However, all of these samples are in the area of medium plasticity and high dry strength on the plasticity chart, these qualities being directly related to the kind and amount of clay minerals present.

The loessial soils would be moderately slow in absorbing water. The plastic range or plasticity index for three of the samples is about 20 percent, which is relatively high for the group of surface materials studied. Swelling and shrinkage would probably be readily apparent upon alternate wetting and drying. As the loessial soils are generally thin in the county, they probably would be removed to reach a better foundation material. Activity values for this group of samples range from 0.59 to 0.94, probably as a result of the effect of a fairly high content of montmorillonite and montmorillonite plus mixed-layer clay minerals. Liquidity indices for the loessial soil samples are low, indicating the soil in place has a stiff consistency.

SUMMARY OF ENGINEERING CHARACTERISTICS

Some of the important engineering characteristics of the various geologic materials in McHenry County studied or observed in the course of this investigation are listed below. The units are listed in approximate order of increasing age.

Unit	Probable Engineering Characteristics
Surficial peat and muck	Compressible; very poor foundation material
Loessial soil	Medium plasticity, high dry strength Moderately slow to drain Would probably swell and shrink upon alternate wetting and drying Material sampled had stiff consistency Inferior foundation material
Accretion gley	High plasticity, very high dry strength Drains very slowly except along joints and fissures Subject to considerable swelling and shrinkage upon alternate wetting and drying Little bearing strength when wet; very poor foundation material
West Chicago drift	Mostly granular materials Little or no plasticity Mostly free draining Not subject to shrinkage and swelling Adequate bearing strength in most situations
Clay (Lake County)	Medium plasticity, high dry strength Almost impermeable from a practical standpoint except along joints and fissures Stiff to very stiff consistency Satisfactory as impervious fill for water impoundment embankments Adequate bearing strength if protected from saturation; might develop some plasticity if saturated
Marseilles till	Low to medium plasticity, medium to high dry strength Drains very slowly Stiff to very stiff consistency Satisfactory material for construction of embankments for impoundment of water

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Unit	Probable Engineering Characteristics
Marseilles till (cont'd)	Adequate bearing strength but might develop some plasticity if allowed to become saturated
Huntley till	Same as for Marseilles till
Gilberts till	Low plasticity, medium dry strength Slow draining Will probably lose some stability if allowed to become saturated Adequate bearing strength when kept dry
Marengo till	Low plasticity, medium dry strength Weathered material has medium plasticity Dries slowly; once saturated, would regain stability very slowly Stiff consistency in upland areas Adequate bearing strength in relatively dry situations, but might lose some stability if allowed to become saturated
Winnebago till	Low plasticity, medium dry strength Very slow to drain Stiff to very stiff consistency; may be hard in dry situations Adequate bearing strength in most situations; might develop some plasticity if allowed to become saturated

TABLE 1 - GRAIN-SIZE ANALYSES AND ATTERBERG LIMITS

		Mechanical composition (% by weight)					Atterberg limits		
			Without gravel						
am- le	Quadrangle & location	Gravel > 2.0 mm	Sand 2.0-.053 mm	Silt .053-.002 mm	Clay <.002 mm	Water content (%)	Liquid (%)	Plastic (%)	Plasticity index (%)
				WINNEBAGO TILL					
41	Harvard 45N5E-19.8h	4	42	45	13	9	17	12	5
				WEATHERED WINNEBAGO TILL					
17	Harvard 46N5E-5.4b	2	38	42	20	15	25	13	12
20	Harvard 46N5E-19.7e	1	41	33	26	16	25	13	12
21	Harvard 45N5E-17.5d	29	39	31	30	14	30	20	10
				MARENGO TILL					
3	Harvard 46N6E-10.3d	8	35	45	20	11	17	12	5
9	Harvard 44N6E-6.6a	2	23	60	17	10	--	--	--
12	McHenry 46N7E-5.5g	6	35	46	19	13	19	12	7
27	Genoa 43N6E-18.8e	4	39	43	18	--	24	13	11
28	McHenry 46N8E-15.7e	3	33	47	20	--	22	13	9
46	Elgin 43N8E-28.6g	5	32	48	20	10	23	14	9
47	Elgin 43N8E-28.6g	4	31	46	23	10	23	14	9
48	Elgin 43N8E-28.6g	6	35	52	13	11	17	12	5
57	Elgin 43N8E-28.6f	5	33	48	19	10	21	13	8
58	Elgin 43N8E-29.2e	6	35	45	20	14	22	14	8
63	Harvard 45N5E-24.8h	11	33	51	16	11	18	12	6
64	Harvard 45N6E-31.8h	8	35	47	18	10	--	--	--
65	Harvard 44N5E-12.1a	1	16	51	33	10	19	13	6
68	Genoa 43N5E-13.2h	5	34	51	15	11	19	13	6
211	Genoa 43N6E-20.8e	12	53	25	22	--	25	14	11

(Continued on next page)

TABLE 1 - Continued

Sample	Quadrangle & location	Mechanical composition (% by weight)				Water content (%)	Atterberg limits		
		Gravel >2.0 mm	Without gravel: Sand 2.0-.053 mm	Without gravel: Silt .053-.002 mm	Without gravel: Clay <.002 mm		Liquid (%)	Plastic (%)	Plasticity index (%)
	WEATHERED MARENGO TILL								
4	Harvard 46N5E-12.4d	2	28	39	33	15	39	17	22
10	Harvard 44N6E-6.6a	3	23	44	33	15	33	16	17
2213	Harvard 44N5E-13.7h	--	30	36	34	--	36	16	20
	GILBERTS TILL								
11	Genoa 43N6E-5.1c	4	31	55	14	--	18	12	6
45	Elgin 43N8E-29.3e	10	30	60	10	12	--	--	--
59	Elgin 43N8E-29.6g	15	36	53	11	8	19	14	5
	WEATHERED GILBERTS TILL								
40	Genoa 43N6E-5.1c	2	34	40	26	24	34	18	16
42	Harvard 44N6E-20.8b	3	37	36	27	34	--	--	--
	MARSEILLES TILL								
7	McHenry 45N7E-17.5h	9	11	54	35	13	27	17	10
25	McHenry 44N6E-25.1c	8	15	61	24	14	23	15	8
26	McHenry 44N6E-21.1e	4	11	59	30	16	27	17	10
33	McHenry 45N7E-10.8b	6	11	57	32	15	27	17	10
43	Elgin 44N6E-36.5e	4	20	60	20	14	22	16	6
44	Elgin 43N7E-5.4h	2	9	59	32	14	30	18	12
66	Elgin 43N8E-29.6d	4	29	50	21	13	30	18	12
67	Elgin 43N7E-25.1e	2	9	50	41	14	35	21	14
2210	McHenry 44N7E-19.1e	2	12	59	29	--	24	16	8

(Continued on next page)

TABLE 1 - Continued

Sample	Quadrangle & location	Mechanical composition (% by weight)				Water content (%)	Atterberg limits		
		Gravel >2.0 mm	Without gravel				Liquid (%)	Plastic (%)	Plasticity index (%)
			Sand 2.0-.053 mm	Silt .053-.002 mm	Clay <.002 mm				
	HUNTLEY TILL								
49	Elgin 43N7E-28.3d	13	19	58	23	14	25	16	9
60	Elgin 43N7E-17.8d	7	10	62	28	14	22	18	4
	CLAY (Lake County)								
50	Grayslake 46N9E-11.5h	--	1	57	42	20	36	20	16
53A	Grayslake 46N9E-27.8a	1	3	63	34	--	33	18	15
53B	Grayslake 46N9E-27.8a	--	1	27	72	27	55	27	28
	WEST CHICAGO TILL								
1	McHenry 46N7E-7.7h	17	52	42	6	5	14	11	3
13	Harvard 46N6E-21.1g	42	48	43	9	8	--	--	--
14	Harvard 46N6E-20.4h	30	47	45	8	7	--	--	--
15	Harvard 46N6E-17.4d	26	59	37	4	10	--	--	--
23	McHenry 45N7E-17.6h	18	54	38	8	12	--	--	--
29	Grayslake 46N9E-5.8c	4	45	50	5	12	--	--	--
35	McHenry 45N7E-27.8a	8	51	41	8	11	--	--	--
36	McHenry 44N7E-10.5h	19	49	44	7	9	--	--	--
37	McHenry 44N8E-18.8g	16	48	47	5	10	--	--	--
39	McHenry 44N7E-13.2g	13	52	43	5	9	--	--	--
51	McHenry 46N8E-17.8b	9	54	41	5	13	--	--	--
55	Elgin 43N8E-23.5h	13	59	36	5	--	--	--	--
56	Elgin 43N8E-14.8a	24	57	37	6	--	19	13	6
62	Harvard 46N6E-32.7d	15	46	45	9	--	--	--	--

(Continued on next page)

TABLE 1 - Concluded

Sample	Quadrangle & location	Mechanical composition (% by weight)				Water content (%)	Atterberg limits		
			Without gravel						
		Gravel >2.0 mm	Sand 2.0-.053 mm	Silt .053-.002 mm	Clay <.002 mm		Liquid (%)	Plastic (%)	Plasticity index (%)
	WEATHERED WEST CHICAGO TILL								
2	Harvard 46N6E-3.3h	2	41	34	25	24	34	20	14
8	McHenry 44N7E-7.4h	9	62	22	16	10	--	--	--
16	Harvard 46N6E-17.4e	15	50	33	17	12	23	15	8
22	Harvard 45N6E-17.5h	30	41	48	11	14	23	15	8
30	Grayslake 46N9E-5.8c	5	51	28	21	24	33	15	18
31	McHenry 46N8E-20.7b	26	58	37	5	19	--	--	--
32	McHenry 46N7E-35.8e	12	44	49	7	11	--	--	--
34	McHenry 46N7E-16.6d	6	24	46	30	10	--	--	--
	WEST CHICAGO SAND AND GRAVEL								
24	Harvard 45N6E-4.1a	47	82	13	5	11	--	--	--
38	McHenry 44N8E-18.8g	40	63	33	4	7	--	--	--
54	McHenry 44N8E-27.6f	55	63	33	4	4	--	--	--
61	Harvard 46N6E-32.7d	38	73	24	3	4	--	--	--
	ACCRETION GLEY								
52	McHenry 46N8E-17.8b	--	4	64	32	24	60	25	35
	LOESSIAL SOIL								
5	Harvard 46N5E-30.2f	--	5	61	34	19	41	21	20
6	McHenry 46N7E-29.3h	1	1	66	33	23	46	26	20
18	Harvard 46N5E-17.6a	7	10	66	24	27	40	20	20
19	Harvard 46N5E-17.6a	6	24	60	16	20	33	18	15

TABLE 2 - RESULTS OF X-RAY ANALYSIS

		Intensities (bulk pack)				Clay mineralogy (parts in ten)				
Sample	Quadrangle & location	Quartz	Dolomite	Feldspar	Calcite	Chlorite	Kaolinite	Illite	Mixed layer plus montmorillonite	Montmorillonite
				WINNEBAGO TILL						
41	Harvard 45N5E-19.8h	500	54	--	22	>2	--	6	<2	--
				WEATHERED WINNEBAGO TILL						
17	Harvard 46N5E-5.4b	90	50	--	--	>2.5	1.5	<3	<3	--
20	Harvard 46N5E-19.7e	200	--	--	--	1.5	>0.5	<3	5	--
21	Harvard 45N5E-17.5d	170	--	--	--	>3	<3	4	--	--
				MARENGO TILL						
3	Harvard 46N6E-10.3d	185	225	--	40	3*	>2	5	--	--
9	Harvard 44N6E-6.6a	92	140	--	16	<5	<1.5	3.5	--	<0.5
12	McHenry 46N7E-5.5g	64	90	--	--	3	1	3	3	--
27	Genoa 43N6E-18.8e	67	58	--	--	<5	>0.5	>3.5	<1	--
28	McHenry 46N8E-15.7e	64	62	78	--	>2.5	1.5	5.5	<0.5	--
46	Elgin 43N8E-28.6g	70	52	--	14	2.5	1.5	5.5	0.5	--
47	Elgin 43N8E-28.6g	74	60	14	Tr	3.5	1.5	4	1	--
48	Elgin 43N8E-28.6g	165	120	Tr	Tr	<2.5	1	<4.5	>2.5	--
57	Elgin 43N8E-28.6f	200	64	--	11	1.5	<1	5.5	>2	--
58	Elgin 43N8E-29.2e	90	68	21	34	>1.5	--	<3.0	>5.5	--
63	Harvard 45N5E-24.8h	140	104	Tr	--	>1	1	<0.5	7.5**	--
64	Harvard 45N6E-31.8h	60	58	10	10	<1	--	>1.5	>7.5	--
65	Harvard 44N5E-12.1a	78	90	--	14	<1.5	<0.5	6	>2	--
68	Genoa 43N5E-13.2h	106	106	--	12	<3	<2	>5	Tr	--
2211	Genoa 43N6E-20.8e	215	--	--	--	2	--	3.5	>4	--

(Continued on next page)

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* Vermiculite and chlorite. ** Mixed layer plus vermiculite.

TABLE 2 - Continued

Sample	Quadrangle & location	Intensities (bulk pack)				Clay mineralogy (parts in ten)				
		Quartz	Dolomite	Feldspar	Calcite	Chlorite	Kaolinite	Illite	Mixed layer plus montmorillonite	Montmoril lonite
	WEATHERED MARENGO TILL									
4	Harvard 46N5E-12.4d	170	145	--	--	<3	<1.5	3.5	>2	--
10	Harvard 44N6E-6.6a	260	--	--	25	>0.5	<0.5	5	--	4
2213	Harvard 44N5E-13.7h	45	--	--	--	>3	<2	<1	--	4
	GILBERTS TILL									
11	Genoa 43N6E-5.1c	235	120	--	Tr	4*	1.5	4.5	--	--
45	Elgin 43N8E-29.3e	78	82	--	10	3	--	7	--	--
59	Elgin 43N8E-29.6g	136	86	--	10	<6	--	>3	<1	--
	WEATHERED GILBERTS TILL									
40	Genoa 43N6E-5.1c	100	--	28	--	2	1	>3.5	<3.5	--
42	Harvard 44N6E-20.8b	106	--	12	--	2	>1	2	--	<5
	MARSEILLES TILL									
7	McHenry 45N7E-17.5h	170	155	65	25	3.5*	>0.5	6	--	--
25	McHenry 44N6E-25.1c	76	75	Tr	12	<4	--	5.5	>0.5	--
26	McHenry 44N6E-21.1e	64	62	--	Tr	2	0.5	7.5	Tr	--
33	McHenry 45N7E-10.8b	50	68	14	14	<2	>0.5	>6.5	<1**	--
43	Elgin 44N6E-36.5e	68	80	10	14	<3	--	>7	--	--
44	Elgin 43N7E-5.4h	62	58	42	10	<2	--	>8	Tr	--
66	Elgin 43N8E-29.6d	76	52	9	10	2	--	8	--	--
67	Elgin 43N7E-25.1e	98	52	Tr	16	<1	Tr	>4.5	4.5	--
2210	McHenry 44N7E-19.1e	31	34	--	5	2	--	7.5	0.5	--

(Continued on next page)

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* Vermiculite and chlorite. ** Mixed layer plus vermiculite.

TABLE 2 - Continued

Sam-le	Quadrangle & location	Intensities (bulk pack)				Clay mineralogy (parts in ten)				
		Quartz	Dolomite	Feldspar	Calcite	Chlorite	Kaolinite	Illite	Mixed layer plus montmorillonite	Montmorillonite
	HUNTLEY TILL									
49	Elgin 43N7E-28.3d	86	100	18	Tr	2	--	8	--	--
60	Elgin 43N7E-17.8d	74	60	--	15	<3	>1	5	>1	--
	CLAY (Lake County)									
50	Grayslake 46N9E-11.5h	60	38	12	12	<3.5	0.5	>6	Tr	--
53A	Grayslake 46N9E-27.8a	--	--	--	--	--	--	--	--	--
53B	Grayslake 46N9E-27.8a	46	16	Tr	12	>2.5	<0.5	6.5	<0.5	--
	WEST CHICAGO TILL									
1	McHenry 46N7E-7.7h	235	330	35	--	>3	--	>2	4.5	--
13	Harvard 46N6E-21.1g	102	110	46	--	<3	<2	>2	3	--
14	Harvard 46N6E-20.4h	134	150	--	--	4	<1	>5	Tr	--
15	Harvard 46N6E-17.4d	72	69	--	--	5	>2	<2	2	--
23	McHenry 45N7E-17.6h	142	90	20	--	2	0.5	>4.5	>2.5	--
29	Grayslake 46N9E-5.8c	154	180	34	--	2.5	0.5	7	--	--
35	McHenry 45N7E-27.8a	135	84	--	--	3.5	--	6.5	--	--
36	McHenry 44N7E-10.5h	148	58	48	--	3.5	<1	5	>0.5	--
37	McHenry 44N8E-18.8g	112	98	8	10	4.5	--	<5	--	>0.5
39	McHenry 44N7E-13.2g	98	80	20	--	2.5	2	<3	>2.5	--
51	McHenry 46N8E-17.8b	200	100	54	Tr	<3	1.5	>4	1.5	--
55	Elgin 43N8E-23.5h	100	176	Tr	--	2	>1	2	<5	--
56	Elgin 43N8E-14.8a	80	152	102	7	>3	<1	5	<1	--
62	Harvard 46N6E-32.7d	94	58	Tr	Tr	4	<2	>4	--	--

(Continued on next page)

TABLE 2 - Concluded

		Intensities (bulk pack)				Clay mineralogy (parts in ten)				
Sample	Quadrangle & location	Quartz	Dolomite	Feldspar	Calcite	Chlorite	Kaolinite	Illite	Mixed layer plus montmorillonite	Montmorillonite
WEATHERED WEST CHICAGO TILL										
2	Harvard 46N6E-3.3h	225	--	28	--	>1.5	1.5	1.5	--	5
8	McHenry 44N7E-7.4h	440	--	--	--	>0.5	>0.5	<0.5	--	<9
16	Harvard 46N6E-17.4e	70	170	--	--	4	<2	3	>1	--
22	Harvard 45N6E-17.5h	74	68	--	--	>2	<2	<0.5	>5.5	--
30	Grayslake 46N9E-5.8c	122	--	--	Tr	<3.5	>1	>1	4.5	--
31	McHenry 46N8E-20.7b	162	--	--	--	3.5	--	6.5	--	--
32	McHenry 46N7E-35.8e	172	94	--	--	>2	<2	6	--	--
34	McHenry 46N7E-16.6d	385	95	Tr	--	4.5	>1.5	2.5	<1.5	--
WEST CHICAGO SAND AND GRAVEL										
24	Harvard 45N6E-4.1a	210	78	--	--	4	>2	<3	1	--
38	McHenry 44N8E-18.8g	60	38	12	12	<4.5	>2	>3.5	--	--
54	McHenry 44N8E-27.6f	32	60	24	18	1.5	--	8.5	--	--
61	Harvard 46N6E-32.7d	190	170	--	10	3	2	>4	<1	--
ACCRETION GLEY										
52	McHenry 46N8E-17.8b	176	--	16	Tr	>1	Tr	4.5	4.5	--
LOESSIAL SOIL										
5	Harvard 46N5E-30.2f	305	--	--	--	2	<2	<1.5	--	<5
6	McHenry 46N7E-29.3h	285	--	--	--	1.5	1	<1	--	>6.5
18	Harvard 46N5E-17.6a	122	--	20	--	3	>0.5	2	<4.5	--
19	Harvard 46N5E-17.6a	152	--	Tr	--	>1.5	1	>1.5	>5.5	--

TABLE 3 - ACTIVITY AND LIQUIDITY INDICES

Sample	Activity = $\frac{I_w*}{\% \text{ clay}}$	Liquidity = $\frac{w - P_w*}{I_w}$
	WINNEBAGO TILL	
41	0.38	-0.60
	WEATHERED WINNEBAGO TILL	
17	0.60	0.17
20	0.46	0.25
21	0.33	-0.60
	MARENGO TILL	
3	0.25	-0.20
12	0.37	0.14
27	0.61	--
28	0.45	--
46	0.45	-0.44
47	0.39	-0.44
48	0.38	-0.20
57	0.42	-0.37
58	0.40	0
63	0.37	-0.17
65	0.18	-0.50
68	0.40	-0.33
2211	0.50	--
	WEATHERED MARENGO TILL	
4	0.67	-0.09
10	0.52	-0.06
2213	0.59	--
	GILBERTS TILL	
11	0.43	--
59	0.45	-1.20
	WEATHERED GILBERTS TILL	
40	0.62	0.37
	MARSEILLES TILL	
7	0.29	-0.40
25	0.33	-0.13
26	0.33	-0.10
33	0.31	-0.20
43	0.30	-0.33
	MARSEILLES TILL (cont'd)	
44	0.38	-0.33
66	0.57	-0.42
67	0.34	-0.50
2210	0.28	--
	HUNTLEY TILL	
49	0.39	-0.22
60	0.14	-1.00
	CLAY (Lake County)	
50	0.38	0
53A	0.44	--
53B	0.39	0
	WEST CHICAGO TILL	
1	0.50	-2.00
56	1.00	--
	WEATHERED WEST CHICAGO TILL	
2	0.56	0.29
16	0.47	-0.37
22	0.73	-0.13
30	0.86	0.50
	ACCRETION GLEY	
52	1.09	-0.03
	LOESSIAL SOIL	
5	0.59	-0.10
6	0.61	-0.15
18	0.83	0.35
19	0.94	0.13

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* I_w = plasticity index; w = natural water content; P_w = plastic limit

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